FINAL REPORT
JUNE 1996

# REPORT NO. 95-21

# PA103E2 UNICHARGE CONTAINERS ON METAL PALLET MIL-STD-1660 TESTS



Prepared for:
U.S. Army Defense Ammunition
Center and School
ATTN: SIOAC-DES
Savanna, IL 61074-9639

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**VALIDATION ENGINEERING DIVISION**
**SAVANNA, ILLINOIS 61074-9639**

ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
Savanna, Illinois

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Bradley J. Haas

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SIOAC-DEV), was tasked by USADACS, Supply Engineering Division (SIOAC-DES), to conduct MIL-STD-1660 tests on a PA103E2 unicharge containers on a metal pallet. This report contains test results with the metal pallet meeting MIL-STD-1660, Design Criteria for Ammunition Unit Loads, requirements.

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| 22a. NAME OF RESPONSIBLE INDIVIDUAL<br>JEROME H. KROHN | 22b. TELEPHONE (Include Area Code)<br>815-273-8929<br>22c. OFFICE SYMBOL<br>SIOAC-DEV |

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U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
VALIDATION ENGINEERING DIVISION
SAVANNA, IL 61074-9639

REPORT NO. 95-21

PA103E2 UNICHARGE CONTAINERS ON METAL PALLET
MIL-STD-1660 TESTS

TABLE OF CONTENTS

# PART 1

## INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SIOAC-DEV), was tasked by USADACS, Supply Engineering Division (SIOAC-DES), to conduct MIL-STD-1660 tests on a metal pallet designed for 36 PA103E2 containers.

B. AUTHORITY. These tests were conducted IAW mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL.

C. OBJECTIVE. The objective of these tests was to determine whether a prototype metal pallet assembly for the PA103E2 container is capable of meeting MIL-STD-1660, Design Criteria for Ammunition Unit Loads, requirements.

D. CONCLUSION. The palletized unit load completed testing with the palletized unit load intact. Minor curvature of the pallet occurred. The palletized unit load passed MIL-STD-1660, Design Criteria for Ammunition Unit Loads, requirements.

PART 2

23 AUGUST 1995 - 3 JULY 1996

ATTENDEES

| | |
|---|---|
| Bradley J. Haas<br>Mechanical Engineer<br>DSN 585-8336<br>815-273-8336 | Director<br>U.S. Army Defense Ammunition Center and School<br>ATTN: SIOAC-DEV<br>Savanna, IL 61074-9639 |
| Jason B. Solberg<br>General Engineer<br>DSN 585-8079<br>815-273-8079 | Director<br>U.S. Army Defense Ammunition Center and School<br>ATTN: SIOAC-DEV<br>Savanna, IL 61074-9639 |

PART 3

## TEST PROCEDURES

The test procedures outlined in this section were extracted from MIL-STD-1660, Design Criteria for Ammunition Unit Loads, 8 April 1977. This standard identifies nine steps that a unitized load must undergo if it is to be considered acceptable. The five tests that were conducted on the test pallets are summarized below.

A. STACKING TESTS. The unit load was loaded to simulate a stack of identical unit loads stacked 16 feet high, for a period of one hour. This stacking load was simulated by subjecting the unit load to a compression weight equal to an equivalent 16-foot stacking height. The compression load was calculated in the following manner. The unit load weight was divided by the unit load height in inches and multiplied by 192. The resulting number was the equivalent compressive force of a 16-foot-high load.

B. REPETITIVE SHOCK TEST. The repetitive shock test was conducted IAW Method 5019, Federal Standard 101. The test procedure is as follows: The test specimen was placed on, but not fastened to, the platform. With the specimen in one position, the platform was vibrated at 1/2-inch amplitude (1-inch double amplitude) starting at a frequency of approximately 3 cycles per second. The frequency was steadily increased until the package left the platform. The resonant frequency was achieved when a 1/16-inch-thick feeler gage momentarily slid freely between every point on the specimen in contact with the platform at some instance during the cycle or a platform acceleration achieved 1 +/- 0.1 Gs. Midway into the testing period, the specimen was rotated 90 degrees and the test continued for the duration. Unless failure occurred, the total time of vibration was two hours if the specimen was tested in one position and three hours for more than one position.

C. EDGEWISE ROTATIONAL DROP TEST. This test was conducted using the procedures of Method 5008, Federal Standard 101. The procedure for the edgewise rotational drop test is as follows: The specimen was placed on its skids with one end of the pallet supported on a beam 4-1/2 inches high. The height of the beam was increased if necessary to ensure that there was no support for the skids between the ends of the pallet when dropping took place, but was not high enough to cause the pallet to slide on the supports when the dropped end was raised for the drops. The unsupported end of the pallet was then raised and allowed to fall freely to the concrete, pavement, or similar underlying surface from a prescribed height. Unless otherwise specified, the height of drop for level A protection conforms to the following tabulation:

| GROSS WEIGHT (WITHIN RANGE LIMITS) (Pounds) | DIMENSIONS OF ANY EDGE, HEIGHT OR WIDTH (WITHIN RANGE LIMITS) (Inches) | HEIGHT OF DROPS ON EDGES | |
|---|---|---|---|
| | | Level A (Inches) | Level B (Inches) |
| 150 - 250 | 60 - 66 | 36 | 27 |
| 250 - 400 | 66 - 72 | 32 | 24 |
| 400 - 600 | 72 - 80 | 28 | 21 |
| 600 - 1000 | 80 - 95 | 24 | 18 |
| 1000 - 1500 | 95 - 114 | 20 | 16 |
| 1500 - 2000 | 114 - 144 | 17 | 14 |
| 2000 - 3000 | Above 145 - No limit | 15 | 12 |
| Above - 3000 | | 12 | 9 |

D. INCLINE-IMPACT TEST. This test was conducted by using the procedure of Method 5023, Incline-Impact Test of Federal Standard 101. The procedure for the Incline-Impact Test is as follows: The specimen was placed on the carriage with the surface or edge which is to be impacted projecting at least 2 inches beyond the front end of the carriage. The carriage was brought to a predetermined position on the incline and released. If it is desired to concentrate the impact on any particular position on the container, a 4- by 4-inch timber was attached to the bumper in the desired position before the test. No part of the timber was struck by the carriage. The position of the container on the carriage and the sequence in which surfaces and edges are subjected to impacts was at the option of the testing activity and depends upon the objective of the tests. This test is to determine satisfactory requirements for a container or pack, and, unless otherwise specified, the specimen was subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified, the velocity at time of impact was 7 feet per second.

5. SLING COMPATIBILITY TEST. Unit loads untilizing special design or non-standard pallets were lifted, swung, lowered and otherwise handled as necessary, using slings of the types normally used for handling the unit loads under consideration. Slings were easily attached and removed. Danger of slippage or disengagement when the load is suspended was cause for rejection of the unit load.

## PART 4

## TEST EQUIPMENT

A. PA103E2 Containers on a Metal Pallet (Test Sample No. 1).

| | |
|---|---|
| 1. Pallet Width: | 35 inches |
| 2. Pallet Length: | 45-1/2 inches |
| 3. Unit Load Weight: | 2,430 pounds |
| 4. Bottom Adapter Lugs: | Buttonless |
| 5. Container Restraint: | None |

B. PA103E2 Containers on a Metal Pallet (Test Sample No. 2).

| | |
|---|---|
| 1. Pallet Width: | 35 inches |
| 2. Pallet Length: | 45-1/2 inches |
| 3. Unit Load Weight: | 2,430 pounds |
| 4. Bottom Adapter Lugs: | Button |
| 5. Container Restraint: | None |

C. PA103E2 Containers on a Metal Pallet (Test Sample No. 3).

| | |
|---|---|
| 1. Pallet Width: | 35 inches |
| 2. Pallet Length: | 45-1/2 inches |
| 3. Unit Load Weight: | 2,430 pounds |
| 4. Bottom Adapter Lugs: | Button |
| 5. Container Restraint: | Intermediate Adapter |

D. PA103E2 Containers on a Metal Pallet (Test Sample No. 4).

| | |
|---|---|
| 1. Pallet Width: | 35 inches |
| 2. Pallet Length: | 45-1/2 inches |
| 3. Unit Load Weight: | 2,430 pounds |
| 4. Bottom Adapter Lugs: | Button |
| 5. Container Restraint: | Intermediate Banding |

E. PA103E2 Containers on a Metal Pallet (Test Sample No. 5).

| | |
|---|---|
| 1. Pallet Width: | 35 inches |
| 2. Pallet Length: | 45-1/2 inches |
| 3. Unit Load Height: | 52 inches |
| 4. Unit Load Weight: | 2,500 pounds |
| 5. Container Restraint: | Intermediate Banding |
| 6. Bottom Adapter: | Corner Lugs |
| 7. Top Adapter: | Non-retractable Lifting Rings |

F. PA103E2 Containers on a Metal Pallet (Test Sample No. 6).

| | |
|---|---|
| 1. Pallet Width: | 35 inches |
| 2. Pallet Length: | 45-1/2 inches |
| 3. Unit Load Height: | 52 inches |
| 4. Unit Load Weight: | 2,500 pounds |
| 5. Container Restraint: | Intermediate Banding |
| 6. Bottom Adapter: | Corner Lugs |
| 7. Top Adapter: | Non-retractable Lifting Rings |

G. Compression Tester

| | |
|---|---|
| 1. Manufacturer: | Ormond Manufacturing |
| 2. Platform: | 60- by 60-inches |
| 3. Compression Limit: | 50,000 pounds |
| 4. Tension Limit: | 50,000 pounds |

H. Transportation Simulator

| | |
|---|---|
| 1. Manufacturer: | Gaynes Laboratory |
| 2. Capacity: | 6,000-pound pallet |
| 3. Displacement: | 1/2-inch amplitude |
| 4. Speed: | 50 to 400 rpm |
| 5. Platform: | 5- by 8-foot |

I. Incline Plane

| | |
|---|---|
| 1. Manufacturer: | Conbur Incline |
| 2. Type: | Impact Tester |
| 3. Grade: | 10 percent incline |
| 4. Length: | 12-foot |

PART 5

## TEST RESULTS

### TEST SAMPLE NO. 1.

A. TEST OBSERVATIONS. The test sample was loaded with 36 PA103E2 containers in the configuration shown in the photograph on page 6-2. No intermediate restraint devices are utilized.

B. STACKING TEST. The test sample was initially loaded to 11,000 pounds compression. The compression was released after one hour. No damage was noted during this test.

C. REPETITIVE SHOCK TEST. The duration of the test was 90 minutes for each orientation of the pallet. The transportation simulator was operated at 131 rpm while the pallet was oriented in the lateral direction. For the longitudinal orientation, the transportation simulator was operated at 206 rpm. The columns of containers moved relative to the adjacent columns. At the completion of the test, the lugs of three containers in the second row from the bottom were disengaged. One bottom adapter lug was also missing.

D. EDGEWISE ROTATIONAL DROP TEST. One side of the pallet was placed on a beam displacing it 4-1/2 inches above the floor. The opposite end of the pallet was raised to a height of 24 inches, then dropped. The first longitudinal drop caused the remaining three lugs of the bottom adapter to shear off. No further testing was performed.

### TEST SAMPLE NO. 2.

A. TEST OBSERVATIONS. This test sample was loaded in the same configuration as test sample no. 1. The bottom adapter had buttonless lugs.

B. STACKING TEST. The test sample was initially loaded to 11,000 pounds compression. While applying the load, the top adapter settled onto the containers. The compression was released after one hour. No damage was noted during this test.

C. REPETITIVE SHOCK TEST. The duration of the test was 90 minutes for each orientation of the pallet. The transportation simulator was operated at 131 rpm while the pallet was oriented in the lateral direction. For the longitudinal orientation, the transportation simulator was operated at 210 rpm. No damage was noted.

D. EDGEWISE ROTATIONAL DROP TEST. One side of the pallet was placed on a beam displacing it 4-1/2 inches above the floor. The opposite end of the pallet was raised to a height of 24 inches, then dropped. The first longitudinal drop caused the outside columns of containers to become unstacked. No further testing was performed.

TEST SAMPLE NO. 3.

A. TEST OBSERVATIONS. This test sample is test sample no. 2 with an intermediate adapter added as shown in photograph on page 6-4.

B. STACKING TEST. The test sample was initially loaded to 11,000 pounds compression. The compression was released after one hour. No damage was noted during this test.

C. REPETITIVE SHOCK TEST. The duration of the test was 90 minutes for each orientation of the pallet. The transportation simulator was operated at 222 rpm while the pallet was oriented in the longitudinal direction. For the lateral orientation, the transportation simulator was operated at 120 rpm. No damage was noted.

D. EDGEWISE ROTATIONAL DROP TEST. One side of the pallet was placed on a beam displacing it 4-1/2 inches above the floor. The opposite end of the pallet was raised to a height

of 24 inches, then dropped. The containers moved out of the stacked position. No further testing was performed.

TEST SAMPLE NO. 4.

A. TEST OBSERVATIONS. This test sample is the same design as test sample no. 2 with intermediate strapping employed between layers of containers. The photograph on page 6-4 shows the locations of the intermediate strapping.

B. STACKING TEST. The test sample was initially loaded to 11,000 pounds compression. The compression was released after one hour. No damage was noted during this test.

C. REPETITIVE SHOCK TEST. The duration of the test was 90 minutes for each orientation of the pallet. The transportation simulator was operated at 160 rpm while the pallet was oriented in the lateral direction. For the longitudinal orientation, the transportation simulator was operated at 170 rpm. No damage was noted.

D. EDGEWISE ROTATIONAL DROP TEST. One side of the pallet was placed on a beam displacing it 4-1/2 inches above the floor. The opposite end of the pallet was raised to a height of 18 inches, then dropped. The first drop caused one container to become unnested. The remaining sides were dropped with no damage occurring to the palletized unit load.

E. INCLINE-IMPACT TEST. The inclined plane was set to allow the pallets to travel 8 feet prior to impacting a stationary wall. The pallet was rotated clockwise after each impact, until all four sides had been tested. No damage resulted from any of the four impacts.

F. SLING COMPATIBILITY TEST. The palletized unit load was lifted by the top adapter using four slings, three slings, two slings diagonal from each other, two slings on the same side, two slings on the same end, and one sling. Lifting the pallet by two lifting rings on the same

side caused the top adapter to bow. The top adapter was bent when the palletized unit load was lifted by 1 lifting ring.

TEST SAMPLE NO. 5.

A. TEST OBSERVATIONS. This test sample contains the redesigned top adapter shown in the photograph on page 6-5. A redesigned bottom adapter employing four corner lugs located outside the edge of the pallet was also used in this test sample.

B. STACKING TEST. The test sample was initially loaded to 10,000 pounds compression. The compression was released after one hour. No damage was noted during this test.

C. REPETITIVE SHOCK TEST. The duration of the test was 90 minutes for each orientation of the pallet. The transportation simulator was operated at 128 rpm while the pallet was oriented in the lateral direction. For the longitudinal orientation, the transportation simulator was operated at 125 rpm. No damage was noted.

D. EDGEWISE ROTATIONAL DROP TEST. One side of the pallet was placed on a beam displacing it 4-1/2 inches above the floor. The opposite end of the pallet was raised to a height of 24 inches, then dropped. A height of 19 inches was used for lateral drops due to pallet dimensions. The top adapter made contact with the forklift during the first drop, causing the top adapter to be dented slightly. No other damage was noted.

E. INCLINE-IMPACT TEST. The inclined plane was set to allow the pallets to travel 8 feet prior to impacting a stationary wall. The pallet was rotated clockwise after each impact, until all four sides had been tested. No damage resulted from any of the four impacts.

F. SLING COMPATIBILITY TEST. The palletized unit load was lifted by the top adapter using four slings, three slings, two slings diagonal from each other, two slings on the same side,

two slings on the same end, and one sling. These lifts created a slight gap between the top adapter and the top of the containers. This space was eliminated when the pallet was placed back on the floor.

TEST SAMPLE NO. 6.

A. TEST OBSERVATIONS. This test sample contains the redesigned sling attachment assembly for the top adapter as shown in the photograph on page 6-7. Redesigned corner lugs for the bottom adapter were also employed.

B. STACKING TEST. The test sample was initially loaded to 11,000 pounds compression. The compression was released after one hour. No damage was noted during this test.

C. REPETITIVE SHOCK TEST. The duration of the test was 90 minutes for each orientation of the pallet. The transportation simulator was operated at 135 rpm while the pallet was oriented in the longitudinal direction. For the lateral orientation, the transportation simulator was operated at 130 rpm. No damage was noted.

D. EDGEWISE ROTATIONAL DROP TEST. One side of the pallet was placed on a beam displacing it 4-1/2 inches above the floor. The opposite end of the pallet was raised to a height of 18 inches, then dropped. The top adapter made contact with the forklift during both lateral drops, causing the top adapter to be dented slightly. No other damage was noted.

E. INCLINE-IMPACT TEST. The inclined plane was set to allow the pallets to travel 8 feet prior to impacting a stationary wall. The pallet was rotated clockwise after each impact, until all four sides had been tested. No damage resulted from any of the four impacts.

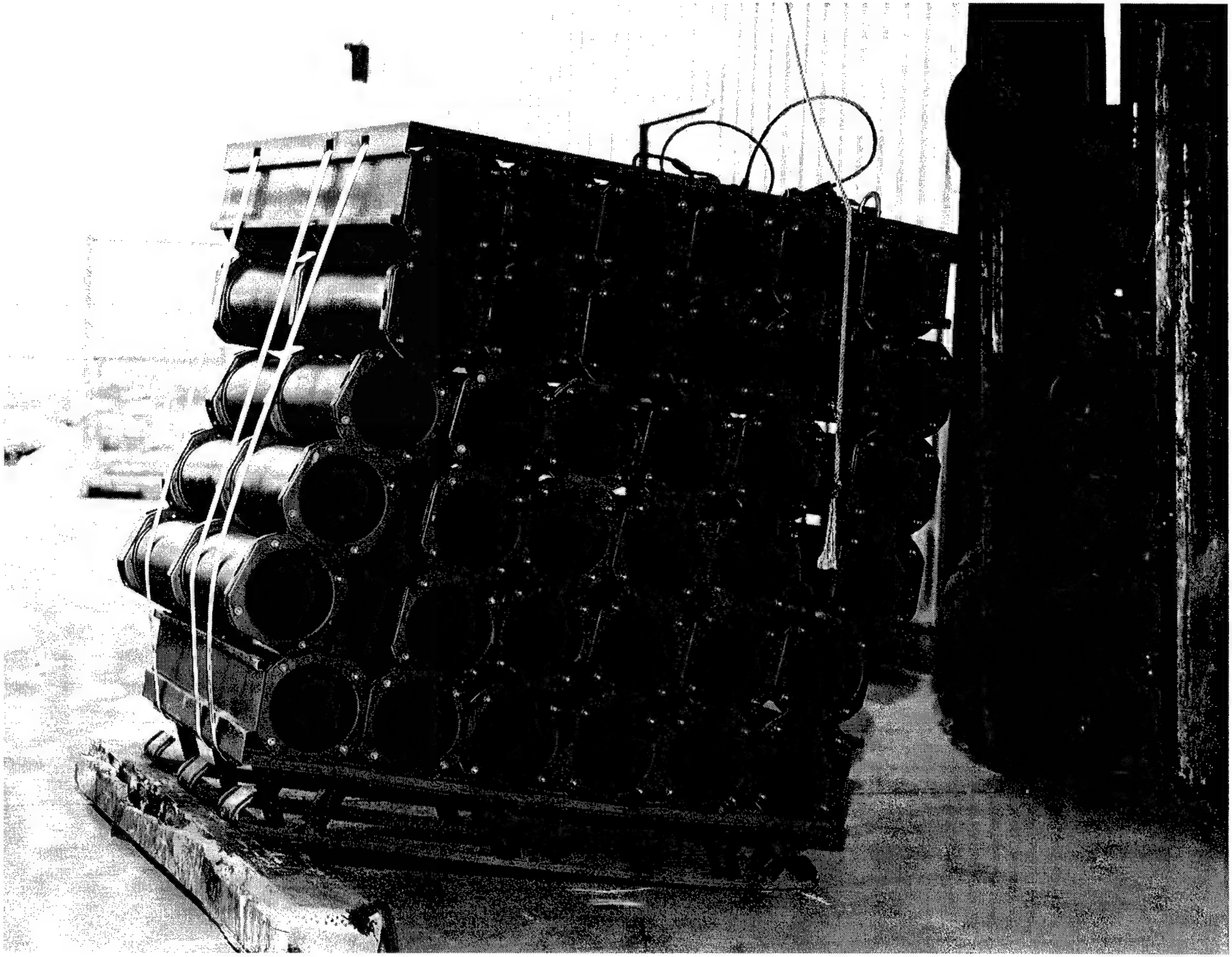
F. SLING COMPATIBILITY TEST. The palletized unit load was lifted by the top adapter using four slings, three slings, two slings diagonal from each other, two slings on the same side,

two slings on the same end, and one sling. These lifts created a slight gap between the top adapter and the top of the containers. At the completion of testing, the maximum space existing between the top adapter and the top of the containers was 1/2-inch on the bell end and 1/4-inch on the opposite end. The palletized unit load remained intact.

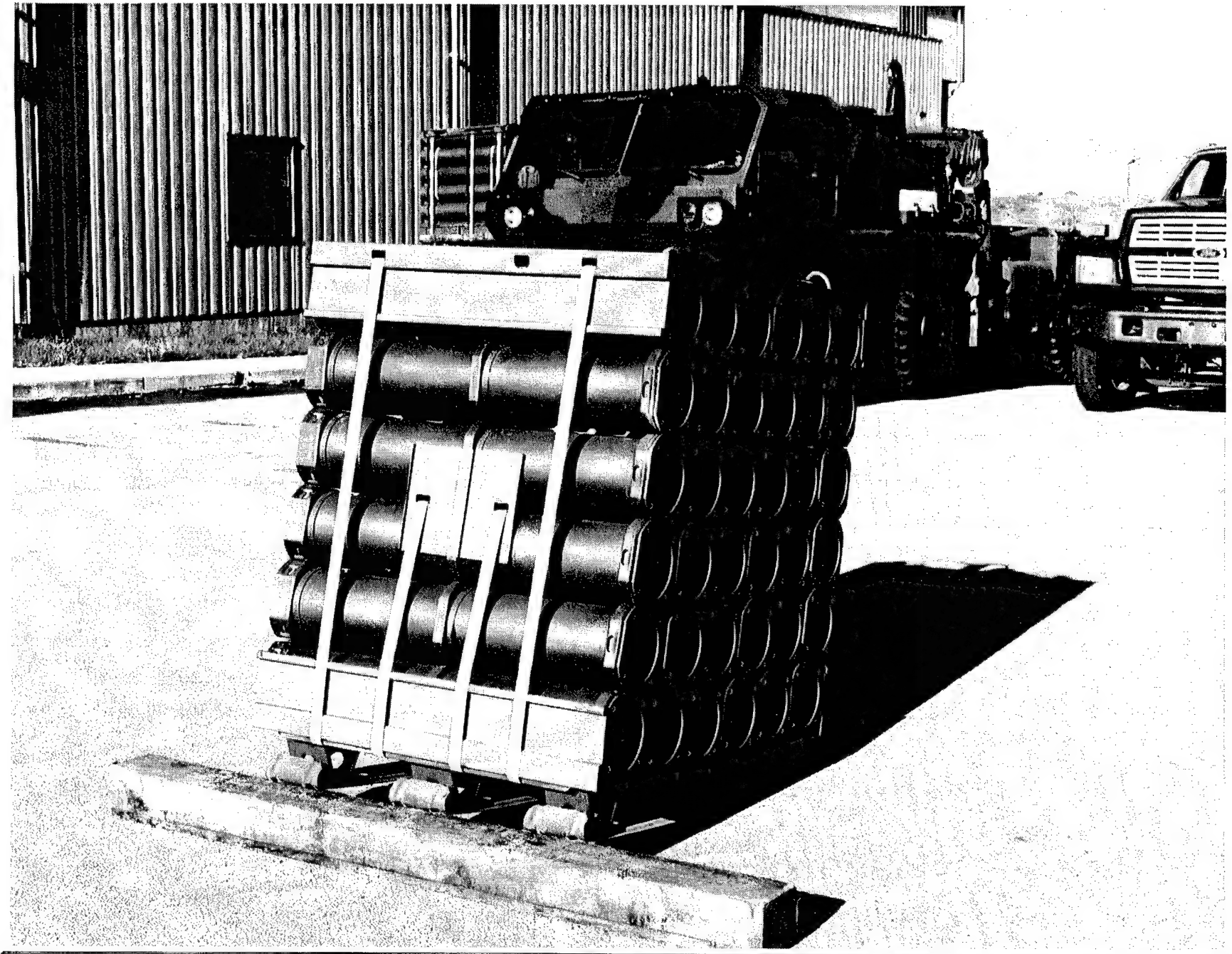
G. END OF TEST. The pallet developed a slight curvature during testing, allowing the pallet to rock when force was applied to one side of the palletized unit load.

# PART 6

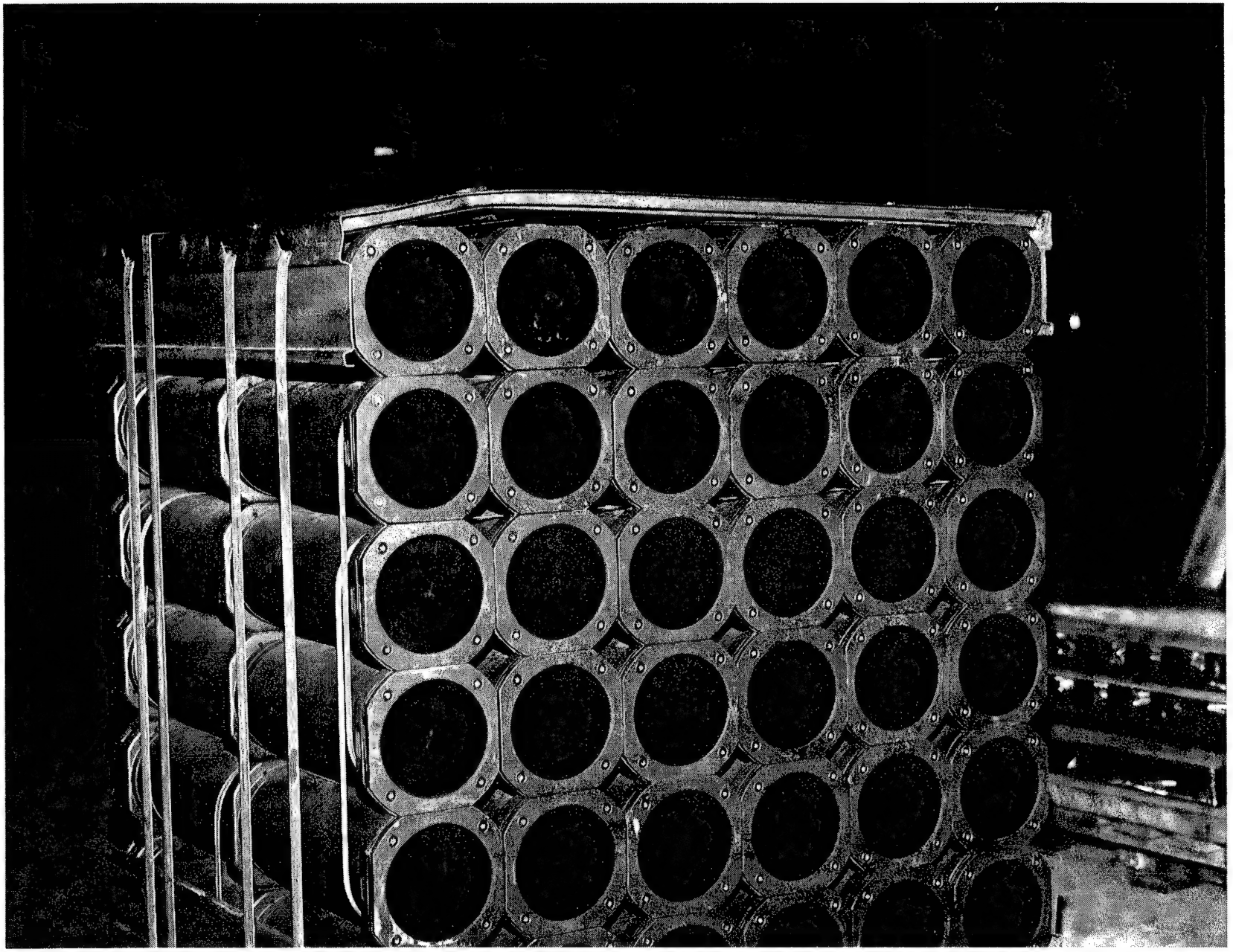
## PHOTOGRAPHS



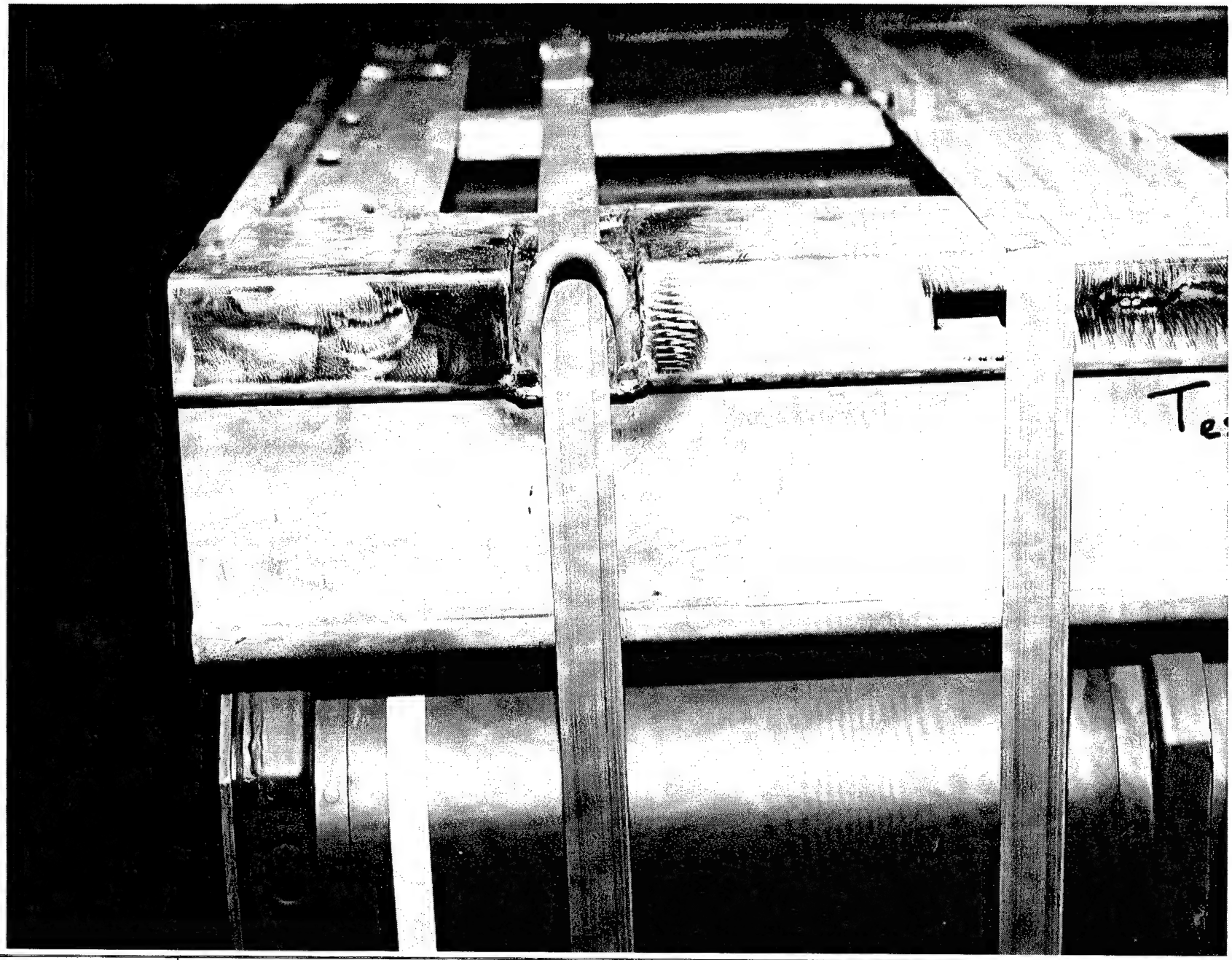
| | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL | |
|---|---|---|
| AO317-SCN95-190-2580. This photo shows test sample no. 2 following the edgewise rotational drop test. | | |



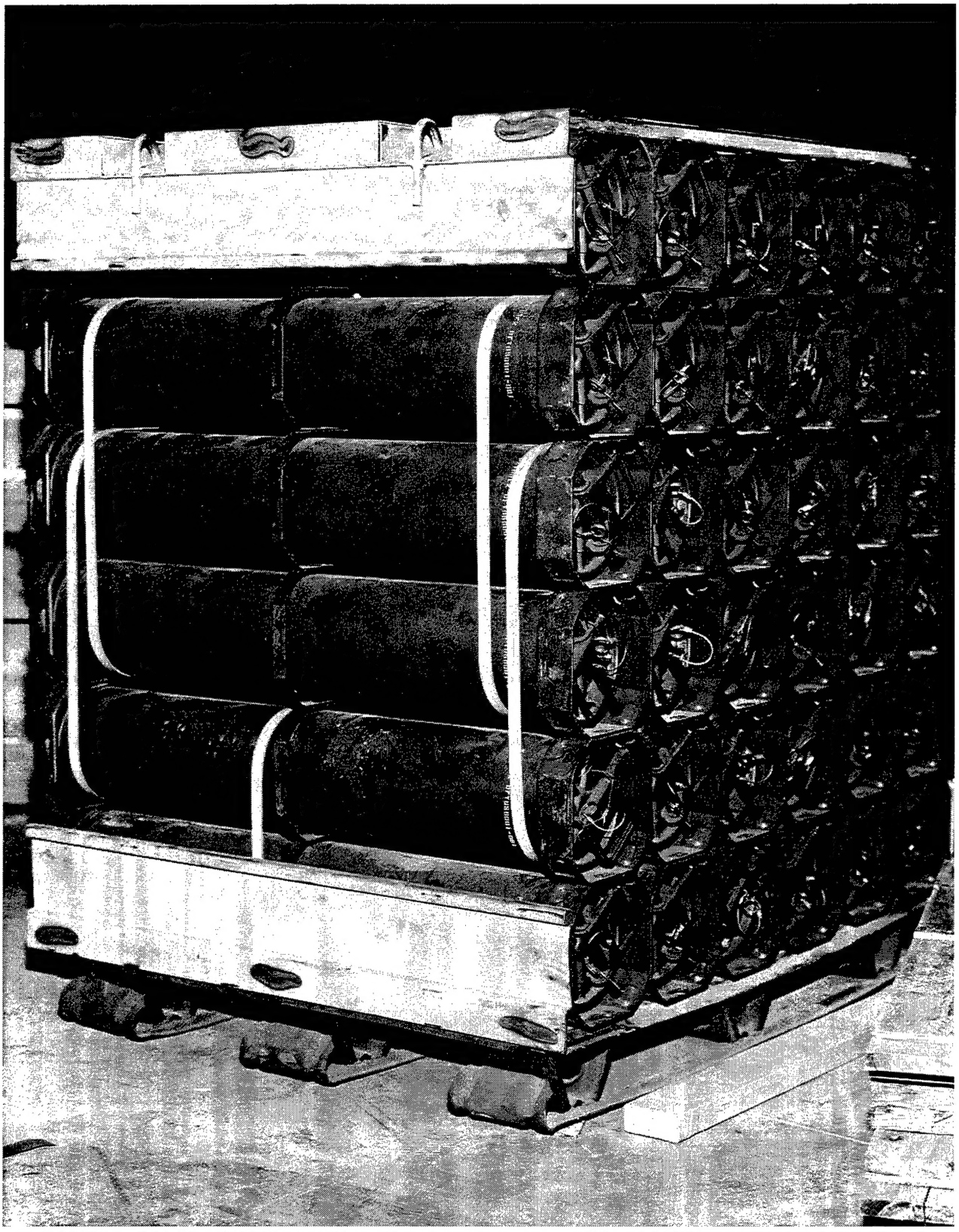
| | | |
|---|---|---|
| | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL | |
| AO317-SCN95-190-2906. This photo shows the intermediate adapter implemented in test sample no. 3. | | |



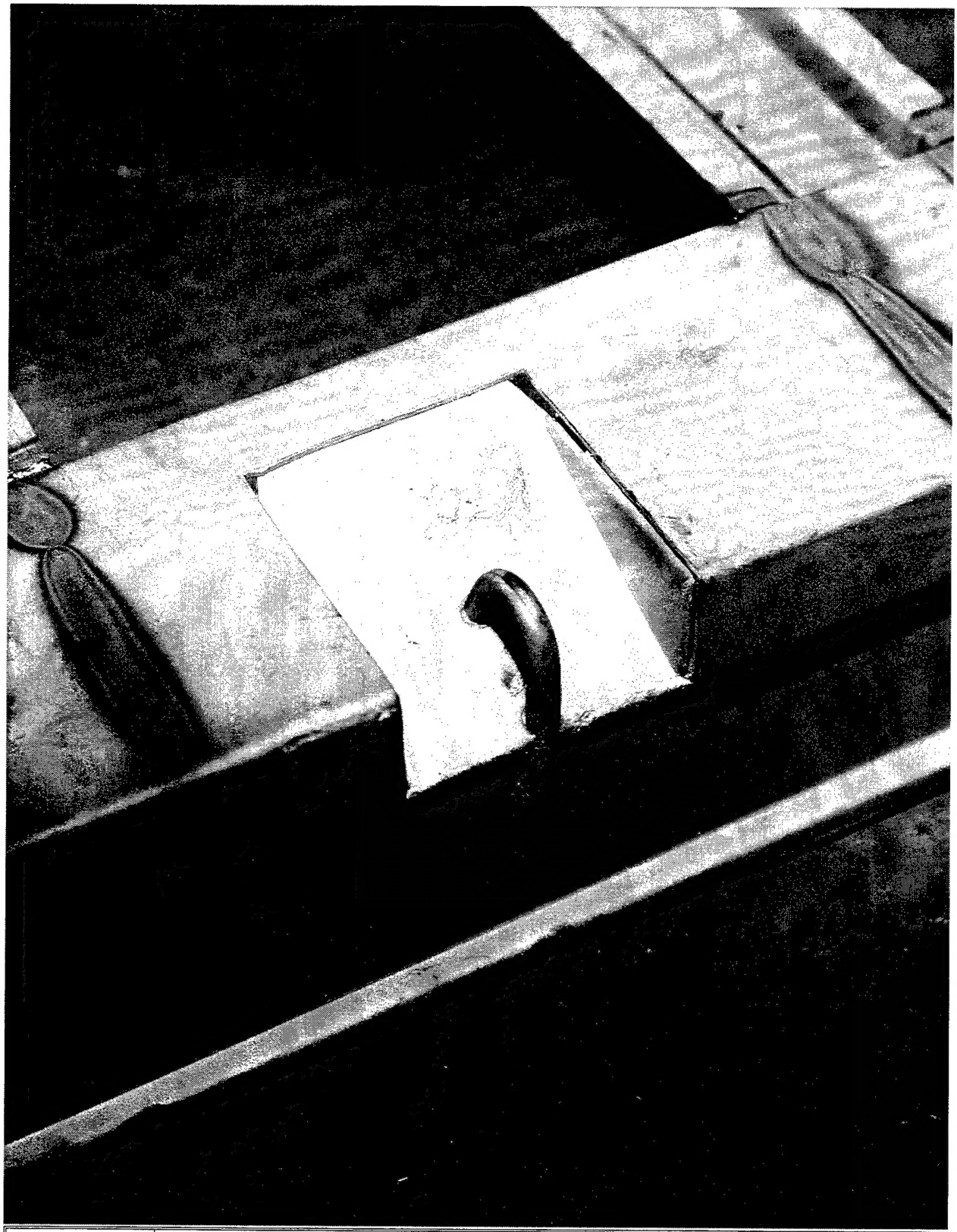
| | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL | |
|---|---|---|
| AO317-SCN96-57-1113. This photo shows the intermediate banding implemented in test sample no. 4. Note the deformation of the top adapter following the sling compatibility test. | | |



| | | |
|---|---|---|
| | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL | |
| AO317-SCN96-81-1524. This photo shows the top adapter utilized for test sample no. 5. | | |



| | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL | |
|---|---|---|
| AO317-SCN96-105-2198. This photo shows test sample no. 6. Note the corner lugs of the bottom adapter. | | |

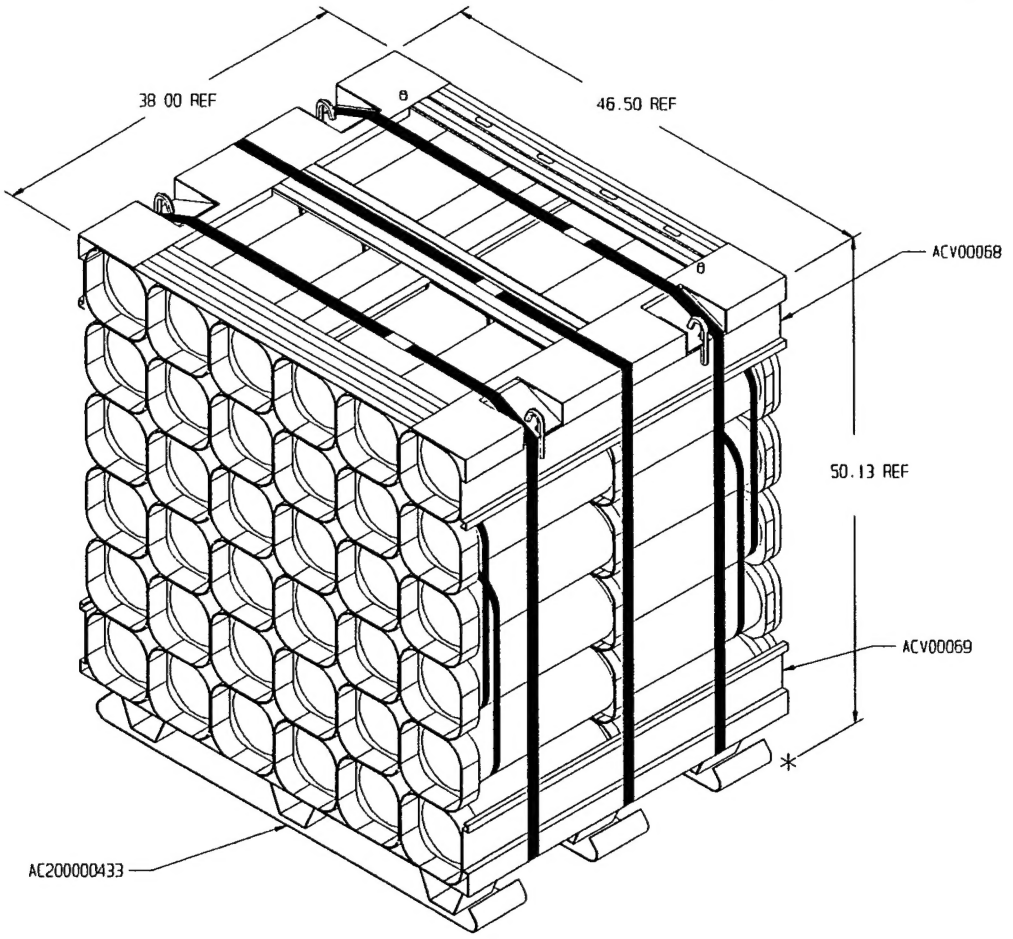


| | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL | |
|---|---|---|
| AO317-SCN96-099-2201. This photo shows the redesigned lifting attachment for the top adapter of test sample no. 6. | | |

# PART 7

## DRAWING

| REVISION | | | |
|---|---|---|---|
| LTR | DESCRIPTION | DATE | APPROVED |
| - | PRODUCT BASELINE<br>ERR M6A2004 | 96-03-29 | |




| COMBINATION OF ADOPTED ITEMS | PART NO |
|---|---|
| PALLET - STANDARD SIZE 45-1/2 X 35 SHEET METAL | AC200000433 |
| TOP ASSEMBLY - PALLET ADAPTER PA103E2 CONTAINER | ACV00068 |
| BOTTOM ASSEMBLY - PALLET ADAPTER PA103E2 CONTAINER | ACV00069 |

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3554M PROP CHG
NEXT ASSY | USED ON
APPLICATION

DATE 96-03-29
DRAWN DLW BJK | CHECKED SMS | PROJ MGR SCHULTZ
SPECIFICATION
SUBMITTED
CHIEF, LOGISTICS ENGINEERING OFFICE
APPROVED BY ORDER OF COMMANDING GENERAL, U.S. ARMY MATERIEL COMMAND (AMC)
CHIEF, SUPPLY ENGINEERING DIV
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COMBINATION OF ADOPTED ITEMS, PALLET & PALLET ADAPTER, UNITIZATION OF PA103E2 CONTAINER

SIZE D | CAGE CODE 28820 | ACV00067
SCALE NONE | UNIT WT | SHEET 1 OF 1